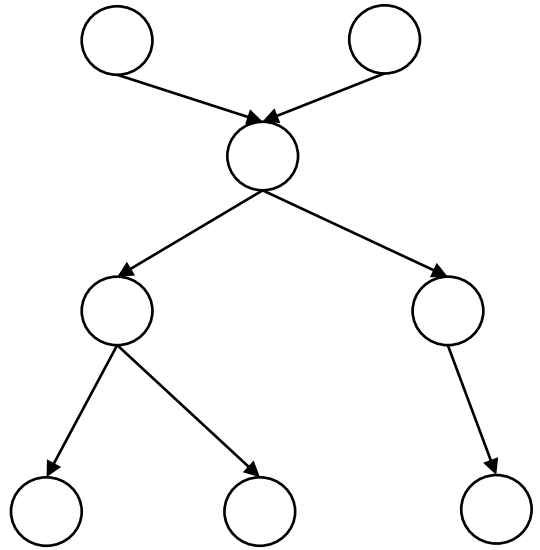
Q1-1: Consider a case with 8 random variables, how many parameters does a BN with the following graph structure have?

1. 24
2. 28
3. 32
4. 52



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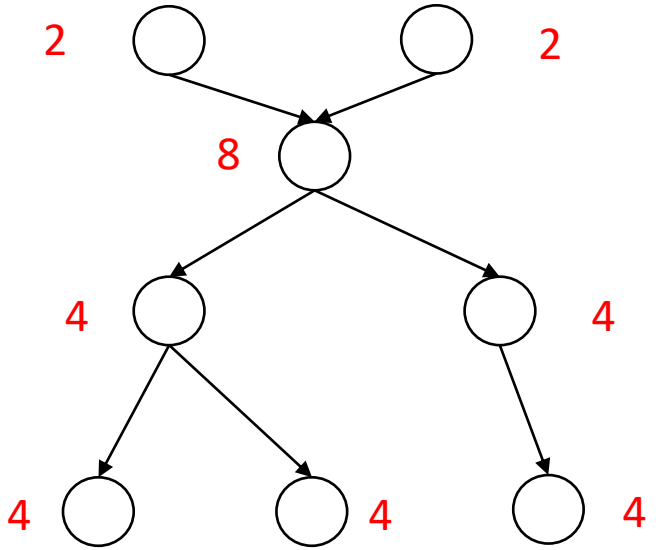

So we have 32 parameters in total.

Q1-2: Are these statements true or false for BN?
(A) If each variable has few parents in the DAG, the distribution can be represented with very few parameters.
(B) The corresponding DAG models the dependencies between variables, and also models conditional probability distributions at each node.

1. True, True
2. True, False
3. False, True
4. False, False

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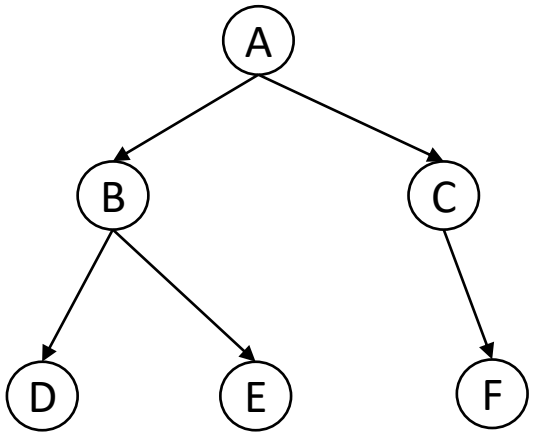
1. True, True
2. True, False ⟵
3. False, True
4. False, False

(A) If a node has fewer parents, then the conditional probability distribution at that node can be represented with fewer parameters.
(B) The DAG can only model the dependencies. It does not place any constraint on how we define our conditional probabilities. It only defines which variables allowed to take in as arguments.

Q2-2: Suppose we are given the query $p(a|d,e,f)$, it can by computed by $p(a|d,e,f) = \frac{p(a,d,e,f)}{p(d,e,f)} = \frac{p(a,d,e,f)}{p(a,d,e,f)+p(\neg a,d,e,f)}$, and $p(a,d,e,f)$, $p(\neg a,d,e,f)$ can be computed in a similar way.
Please compute $p(a,d,e,f)$ based on the following graph structure.



1. $p(a)\sum_{b,\neg b}\sum_{c,\neg c} p(B)p(C|a)p(d|B)p(e|B)p(f|C)$
2. $p(a)\sum_{b,\neg b}\sum_{c,\neg c} p(B)p(C)p(d|B)p(e|B)p(f|C)$
3. $p(a)\sum_{b,\neg b}\sum_{c,\neg c} p(B|a)p(C)p(d|B)p(e|B)p(f|C)$
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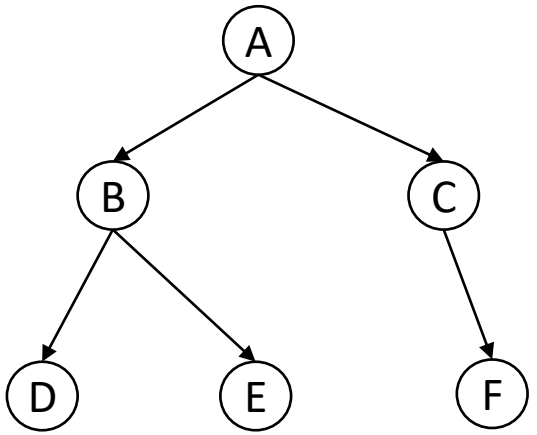

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3. $p(a)\sum_{b,\neg b}\sum_{c,\neg c} p(B|a)p(C)p(d|B)p(e|B)p(f|C)$
4. $p(a)\sum_{b,\neg b}\sum_{c,\neg c} p(B|a)p(C|a)p(d|B)p(e|B)p(f|C)$ ⬅

By the graph structure, we can see that $p(A,B,C,D,E,F) = p(A)p(B|A)p(C|A)p(D|B)p(E|B)p(F|C)$.
Plug in values of a,d,e,f and enumerate values over B,C, we get the expression above. P(a d e f) = \sum_{B ,C } P(a B C d e f)